

# Energy Efficiency and Financial Value



Lawrence Berkeley National Laboratory  
Paul Mathew, Staff Scientist  
[pamathew@lbl.gov](mailto:pamathew@lbl.gov) | 510-486-5116

# Project Summary

## Timeline:

Start date: Oct 2016

Planned end date: on-going

## Key Milestones

1. Analysis of data from at least two real estate portfolios; 12/15/18
2. Final papers from RERI RFP research projects; 4/30/19

## Budget:

### **Total Project \$ to Date:**

- DOE: \$385K (FY17-19)
- Cost Share: \$95K

### **Total Project \$:**

- DOE: \$385K (FY17-19)
- Cost Share: \$95K

## Key Partners:

Real Estate Research Institute	UNC Chapel Hill
2 portfolio owners	University of Cambridge
New York University	University of Guelph
Maastricht University	University of Reading
Tilburg University	University of Washington
University of Arizona	York University

## Project Outcome:

Empirical evidence of financial value is key to sustain and increase demand for and investment in green buildings. The goal of this project is to a) conduct research on the relationship between energy efficiency and financial value of commercial buildings; and b) disseminate actionable insights from these results to real estate stakeholders.

*This project supports BTO CBI MYPP strategy #3*

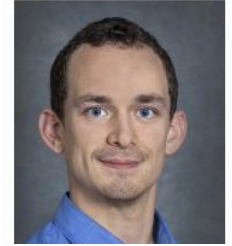
# Team



LBNL manages the project, leads engagement with industry and academic groups to frame research questions and manages projects conducted by academic partners. LBNL also conducted analysis on two real estate portfolios.



P. Mathew



T. Walter



The Real Estate Research Institute (RERI) commissions research on real estate investment performance through an RFP process.

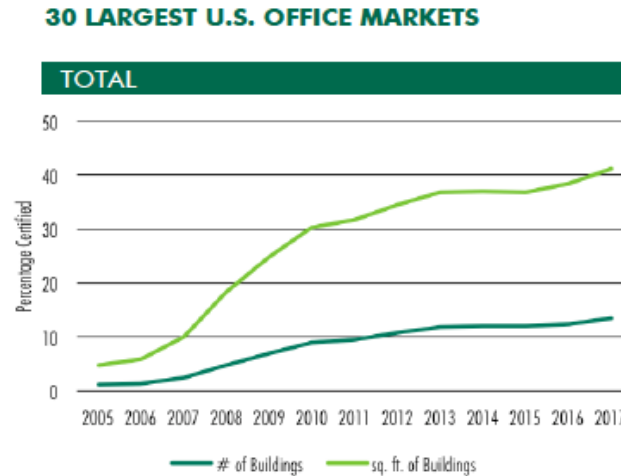
RERI has provided funding for over 150 research papers of interest to institutional real estate investors.

*DOE Manager: Cindy Zhu*

# Challenge

## First, some good news:

In 2017, over **41%** of commercial office space in the **top 30 U.S. markets** was certified as “green” or “efficient” showing significant, growth from 5% in 2005.



Source: 2018 U.S. Green Building Adoption Index, CBRE

## The challenge:

Real estate investors and other stakeholders want to know:

*Do energy efficiency and “green” features actually improve the financial value of buildings? By how much? In what locations? In what types of buildings?*

Empirical evidence of financial value is key to sustain and increase demand for and investment in green buildings, beyond just ESG motivations.

# Approach

## Frame Research



Industry working group

Academic working group

Literature review &  
Gap analysis

2015-2017

## Conduct Research



Collaboration with Real Estate Research Institute (RERI)

RFP for research projects

Analysis of two portfolios

2018-2019

*Focus of this peer review*

## Inform Stakeholders



Research findings summaries

Presentations at stakeholder venues

# Approach: Framing the Research Question

*“How does <energy/green metric> affect <financial value metric>?”*

Energy/Green Metric
Site energy use or EUI
Source energy use or EUI
Energy cost or cost/sf
ENERGY STAR score
ENERGY STAR label
Green Building Certification (LEED, BOMA 360...)
Green Building Certification level (e.g., LEED Silver, Gold)

?

Financial Value Metric	
Vacancy/Occupancy	Sales Price
Leasing Velocity (absorption, speed of sales, leasing)	Regulatory & Compliance Risk
Tenant Renewals	Insurance (rates, ability)
Tenant Satisfaction	Default Risk
Rental Income and Rent Concessions	Debt Service Coverage Ratio
Marketing Costs	Access to Funding
Utility Costs, Maintenance, OpEx	Interest Rates
Obsolescence	Reserves
Capitalization Rates	

# RERI-LBNL RFP

- Collaboration with RERI to issue RFP
  - Leverage existing process, experience, network
- Selection Criteria:
  - Alignment with DOE goals
  - Impact on Real Estate Industry
  - Feasibility
  - Team qualifications
- 12 proposals received
- 5 projects selected

**RERI Sponsors**  
**Sustaining Sponsor**  
Pension Real Estate Association  
**Sponsors**  
AEM Capital Management, LP  
Alta Group  
Automotix, Inc.  
Bainbridge Real Estate Advisors  
CBRE Economics Advisors  
Clarian Partners  
Collier Group  
Deutsche Asset & Wealth Management  
Green Street Advisors  
Holtman  
International Council of Shopping Centers  
(ICSC)  
Inverco Real Estate  
LaSalle Investment Management  
MBCI  
National Association of Real Estate  
Investment Trusts (NAREIT)  
National Council of Real Estate  
Investment Fiduciaries (NCREIF)  
National Investment Center for the Senior  
Housing & Care Industry (NCSH)  
National Multi Housing Council (NMHC)  
Principal Real Estate Advisors  
PJM Real Estate  
ROLOO  
Real Capital Analytics  
RealPage, Inc.  
BNL Financial LLC  
TH Real Estate  
Thryx, LLC  
USG Global Asset Management  
USAA Real Estate Company

**2018 Special Request for Research Proposals**  
**Real Estate Research Institute  
and Lawrence Berkeley  
National Laboratory (LBNL)**  
**\$10,000 - \$50,000 Available to fund real estate research**  
**Proposal submission deadline: April 16, 2018**  
**Overview**  
Lawrence Berkeley National Laboratory (LBNL) has spent the past several years collaborating with the commercial real estate industry to understand research questions that are of particular interest and could provide actionable results for market stakeholders. Having received input from these key stakeholders, LBNL, through RERI, now seeks proposals for funding of research to be undertaken in 2018.  
LBNL aims to facilitate research that will provide empirical, quantitative, market-focused research results in areas that have not been sufficiently explored around energy, green building features and financial value. Specifically, the intent is to generate meaningful, actionable results capable of influencing commercial real estate practitioners – such as owners, managers, investors – and encouraging greater investment in energy efficient technologies, retrofits, and buildings.  
**Logistics**  
Projects involving researchers from different disciplines or jointly undertaken by academic researchers and industry professionals are strongly encouraged. Proposals may involve research that is underway, but not substantially completed, at the time of application. With the exceptions of university and college settings and academic conferences, partial or completed research cannot be presented to any organization prior to presentation at the RERI Conference. Completed projects must include a two-page executive summary that synthesizes the research thesis, key results and next steps if appropriate. Authors should note that a separate, nontechnical summary that emphasizes implications for industry practitioners or investors with a limited background in quantitative analysis may be created by the LBNL team member/designee of RERI's board/advisory board and posted to the RERI website.  
Grants may range from \$10,000-\$50,000, but we are open to considering smaller or larger proposals for exceptional reasons. Research projects that are funded and successfully completed will be eligible for presentation at the DOE's Better Buildings Summit.

**Deadline for receipt of proposal to RERI:**  
**April 16, 2018 Midnight EST** Proposals  
and information requests should be e-  
mailed to:  
reri@energy.gov  
The Real Estate Research Institute  
100 Pearl Street, 13<sup>th</sup> Floor  
Hartford, CT 06103  
USA  
Telephone: (860) 882-8341

# RERI RFP: Five diverse projects

Title	Institutions	Key Metrics
The Impact of Environmental Interventions on CRE Operations	Univ. of York Univ. of Guelph	E*, LEED NOI, opex
The Dynamics of Energy Consumption in Commercial Real Estate	Maastricht U. Univ. of Guelph	Bldg. cert., energy use, EE CapEx,
Effect of Energy Benchmarking and Disclosure on Office Bldg. Marketability	Univ. of Washington	E*, EUI, occupancy rates
Estimating Office and Residential Building Energy Retrofit Hurdle Rates	NYU, U of Arizona, UNC Chapel Hill, Cambridge Univ.	Energy savings, CapEx IRR
ESG Insights in Public Real Estate Performance	Tilburg Univ, Univ. Of Reading	ESG ratings, REIT returns



# The Impact of Environmental Interventions on CRE Operations

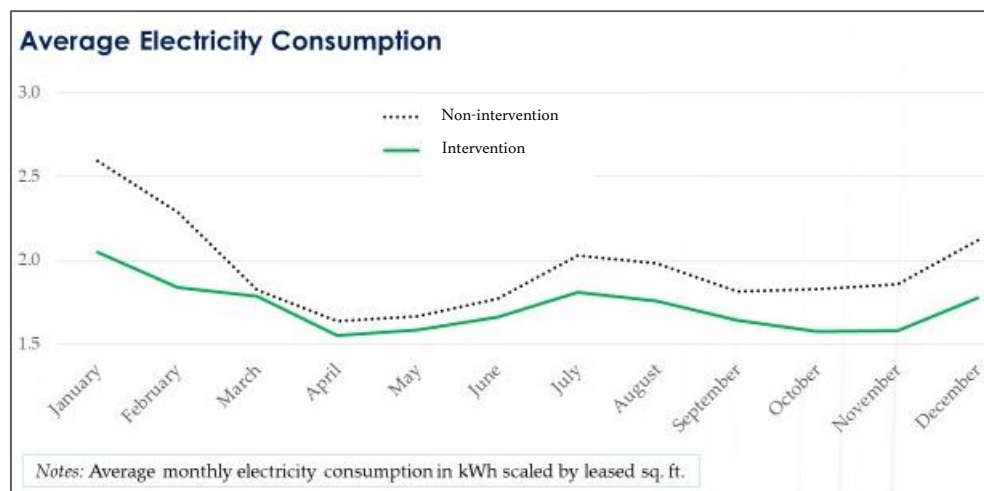
**Team:** J. Clayton, A. Devine, R. Holtermans

**Research question(s):** What is the impact of various environmentally-focused building interventions on utility consumption and the building's operating statement?

**Approach:** Stringent fixed effects models utilizing 15 years of building-level data on 255 office buildings managed by Bentall Kennedy in the US & Canada

## Key findings to date:

- *Tenant Engagement programs:*
  - ↓ electricity consumption;
  - ↑ NOI (Canada);
  - ↓ op Expenses (US)
- *Certification programs:*
  - ↓ water in suburban prop.
  - ↓ gas in core buildings



First Look at Tenant Intervention Impact

# The Dynamics of Energy Consumption in Commercial Real Estate

**Research Team:** P. Eichholtz, R. Holtermans, and N. Kok

**Research question:** How are environmental building certification and specific building interventions related to energy consumption in commercial buildings?

**Approach:** Building-fixed effects model relating certification and interventions to monthly consumption. Data for the 2009-2018 period on 7,258 buildings in the U.S. (office, residential, industrial, retail)

## **Key findings to date:**

- Environmental building certification associated with a decrease in energy consumption. Significant heterogeneity across program type, certification level, and certification tenure.
- Energy efficiency improvements associated with a reduction in energy consumption (e.g. lighting, HVAC, building controls retrofits).

# Effect of Energy Benchmarking and Disclosure on Office Building Marketability

**Team:** S. Dermisi, H.W. Lee, Y Choe, L. Shang

## Research questions:

- Did benchmarking policy affect the real estate performance of office buildings?
- Do energy efficient buildings cluster spatially?

## Approach:

- Interrupted time series analysis (ITSA) of energy benchmarking data and occupancy rates for Chicago, New York, San Francisco, Washington DC.
- Hot spot analysis.

## Preliminary findings:

- Some differences in occupancy trends between more and less efficient buildings after policy implementation, but difficult to parse impacts.

# Estimating Office and Residential Building Energy Retrofit Hurdle Rates and Risk Arbitrage in Energy Efficiency Investments

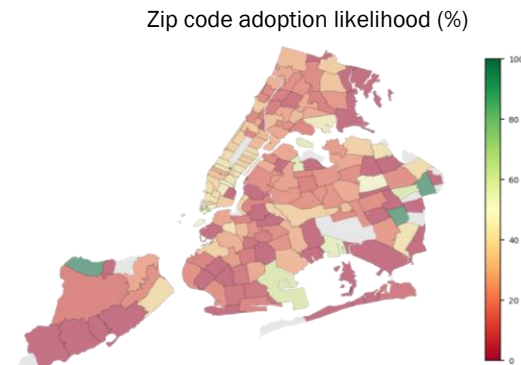
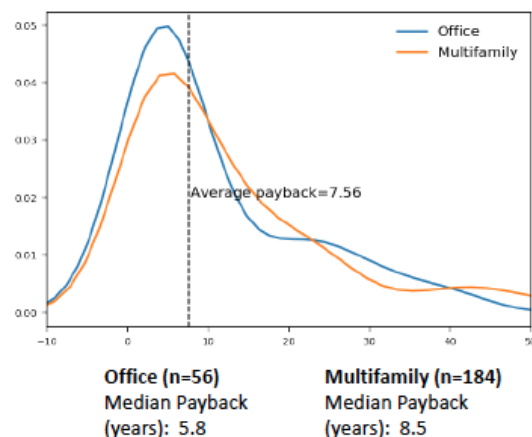
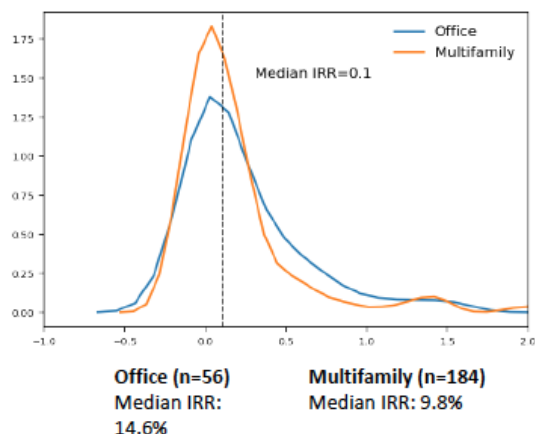
**Team:** C. Kontokosta (NYU), F. Fuerst (U Cambridge), G. Pivo (U Arizona), J. Sagi (U North Carolina-Chapel Hill), Y. Lai (NYU), S. Papadopoulos (NYU).

**Research Question:** What is the hurdle rate for energy retrofit investments in office and residential buildings?

## Approach:

- Use 4,000+ actual energy audit reports (NYC LL87 data) to calculate NPV curves for each building.
- Using a natural language processing (NLP) algorithm, match audit recommendations and reported renovation work (NYC DOB permit data) for each building to estimate ECM adoption likelihood.
- Model the required rate of return for energy retrofit investments.

**Key Findings:** ECM adoption is ~10% of buildings, varying by property value, building type, and local renovation intensity. Median IRR of 14.6% in office and 9.8% for multi-family



Median IRR and payback based on ECM adoptions

# ESG Insights in Public Real Estate Performance

**Team:** D. Brounen (Tilburg University, NL) and G. Marcato (University of Reading, UK)

**Research Question:** Relationship between Environmental, Sustainable and Corporate Governance (ESG) ratings and public real estate performance in the US REIT market

## Approach:

- Data: ESG scores from GRESB, Reuters, KLD (MSCI). Sample Period: 2002-2017
- Method: 5 factors asset pricing model + ESG factor

## Key findings:

- ESG metrics differ significantly, with GRESB tilted towards “E”, and KLD tilted towards “G”.
- REITs with high ESG scores tend to be much larger than average.
- While controlling for size, we find that high ESG scores:
  - ✓ Trigger a REIT return premium (Reuters and KLD)
  - ✓ Took time to yield appreciation, with return discounts in the early years (learning curve)
  - ✓ Mostly appreciated because of “S” and “G”

**Table 3 |** ESG metric weighting schemes

	GRESB	Thomson Reuters	KLD (MSCI)
<b>E</b>	57%	34%	17%
Energy score	15%	✓	✓
GHG score / Climate change	3.60%	✓	✓
Water score	4.70%	✓	✓
Waste score	5.10%	✓	✓
Technical building assessment	3.30%		✓
Monitoring & environmental management system	14%	✓	
Building certifications	10.90%		
Raw material sourcing		✓	✓
Biodiversity and land use		✓	✓
Environmental policy			
Environmental supply chain incidents			
<b>S</b>	18%	35.5%	25%
Sustainability focused community engagement process	2.20%		
Community engagement impact monitoring	1.10%	✓	
Tenant engagement and satisfaction	8%		
Employees' training and satisfaction / Human capital	5.80%	✓	✓
Product liability (safety)		✓	✓
Controversial sourcing			✓
Social opportunities			✓
Policy on freedom of association		✓	
Policy on elimination of discrimination		✓	
Customer responsibility		✓	
<b>G</b>	25%	30.5%	58%
Management / Corporate governance	8.80%	✓	✓
Policy & Disclosure	9.50%	✓	✓
Sustainability risk assessments	5.10%		
Tax transparency			✓
Anti-competitive practice			✓
Signatory to UN global compact			

# Analysis of two RE portfolios with lease data

Research question: “What are the effects in my portfolio?”

*Financial metrics*  
Vacancy (%)  
Lease gap (days)  
Market value (\$/sf)

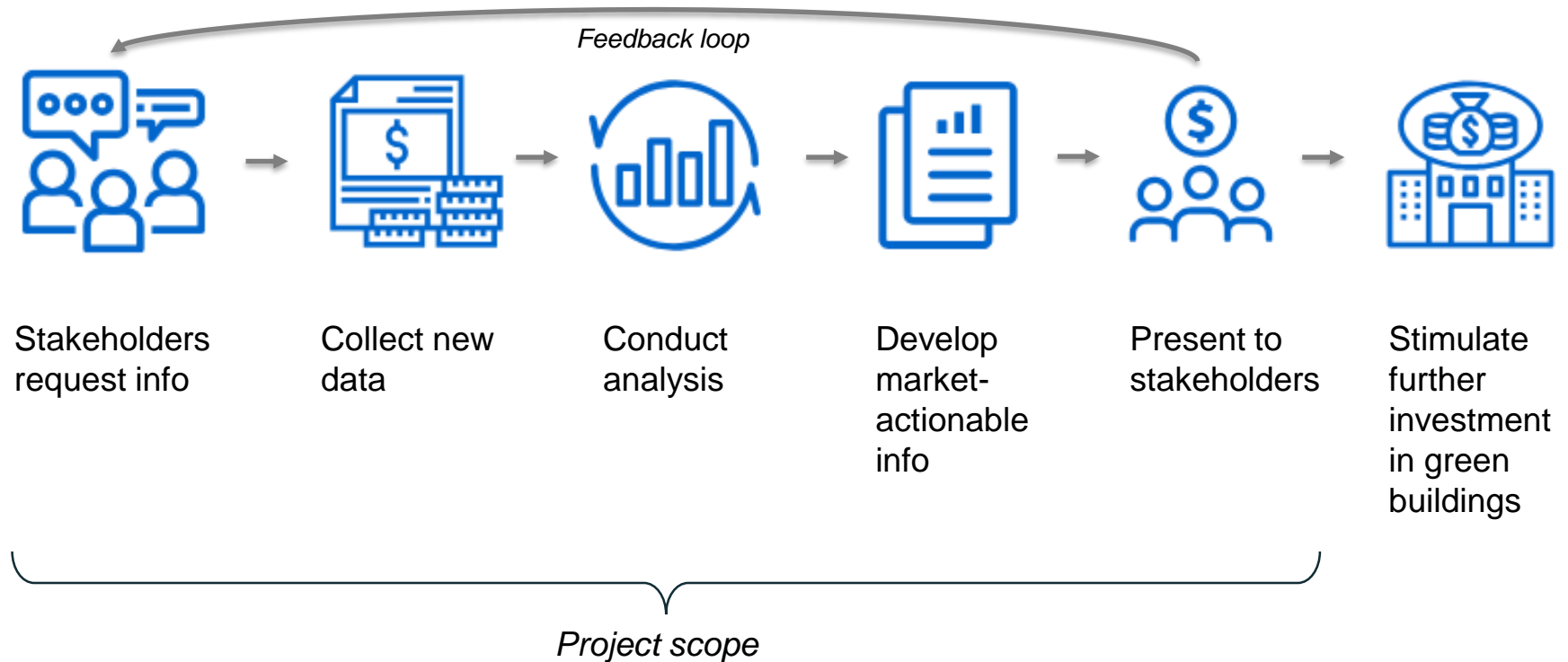
*Energy metrics*  
Site energy (kBtu/sf)  
Src energy (kBtu/sf)  
Energy cost (\$/sf)  
Tot. utility cost (\$/sf)  
Energy Star Score  
Energy Star Label  
LEED certification

*Control metrics*  
Building type  
Year built  
Class (A/B/C)  
Metro area GDP Household  
income  
Market value

- Individual and combined analysis of two portfolios.  
Linear regression models:  
 $\text{<financial metric>} = f(\text{<energy metric>}, \text{<control metrics>})$   
e.g.  $\text{market value} = f(\text{ES score}, \text{year built}, \text{class}, \text{metro GDP})$
- Found a statistically significant relationship between Energy Star label and vacancy rate in offices.
- Building heterogeneity and lack of data on building characteristics remains a major limitation for such analyses, creating “signal-to-noise” issues.

# Impact

## Theory of change



*Research results do not directly save energy – they provide information needed to sustain and grow real estate investment in energy efficiency (directly supports CBI MYPP strategy #3)*

# Progress (2018-19)

## Research Projects

- Selected 5 research projects via RFP process.
- Substantial progress (>90%) on all projects
- Analysis of two RE portfolios

## On-going data collection

- Signed NDAs and collected data from two RE portfolios – market value, rent rolls, energy metrics

## Stakeholder engagement

- Collaboration with RERI
- Presentations at NAREIM, NAREIT, Greenbuild



# Stakeholder Engagement

## Engagement with real estate community via RERI partnership

### Sustaining Sponsors



**Pension Real Estate Association (PREA)**  
PREA's mission is to serve its members engaged in institutional real estate investment through the sponsorship of objective forums for education, research initiatives, membership interaction and the exchange of information.

### Sponsors



## Engagement with academic research community via RFP process and anticipated journal publications

# Remaining Project Work

The project is mostly completed



## Potential future work:

- (Re)constitute real estate stakeholder working group with periodic meetings to identify research questions and review new results
- Fund a new cycle of research projects through the RFP process.

---

# Thank You

**Paul Mathew, Staff Scientist**  
**Lawrence Berkeley National Laboratory**  
**pamathew@lbl.gov | 510-486-5116**

---

# REFERENCE SLIDES

# Project Budget

**Project Budget:** The project was funded in FY17 and FY18. FY19 uses carryover from prior years.

**Variances:** None

**Cost to Date:** \$161,286 (as of Feb 28, 2019)

**Additional Funding:** None

## Budget History

FY2017 – FY 2018 (past)		FY 2019 (current)		FY 2020 – TBD (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
\$295K	\$0K	\$90K	90K	TBD	TBD

# Project Plan and Schedule

Project Schedule												
Project Start: Oct 2016	Completed Work											
Projected End: Sep 2019	Active Task (in progress work)											
	◆	Milestone/Deliverable (Originally Planned)?										
	◆	Milestone/Deliverable (Actual)?										
	FY2017				FY2018				FY2019			
Task	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)
Past Work												
Create Infrastructure for collecting data	◆											
Finalize NDA for data providers	◆											
RFP for Research Proposals Developed and Advertised						◆						
Final Researchers Selected							◆					
Current/Future Work												
Analysis of data from at least two real estate portfolios									◆			
Final papers from RERI RFP research projects										◆		